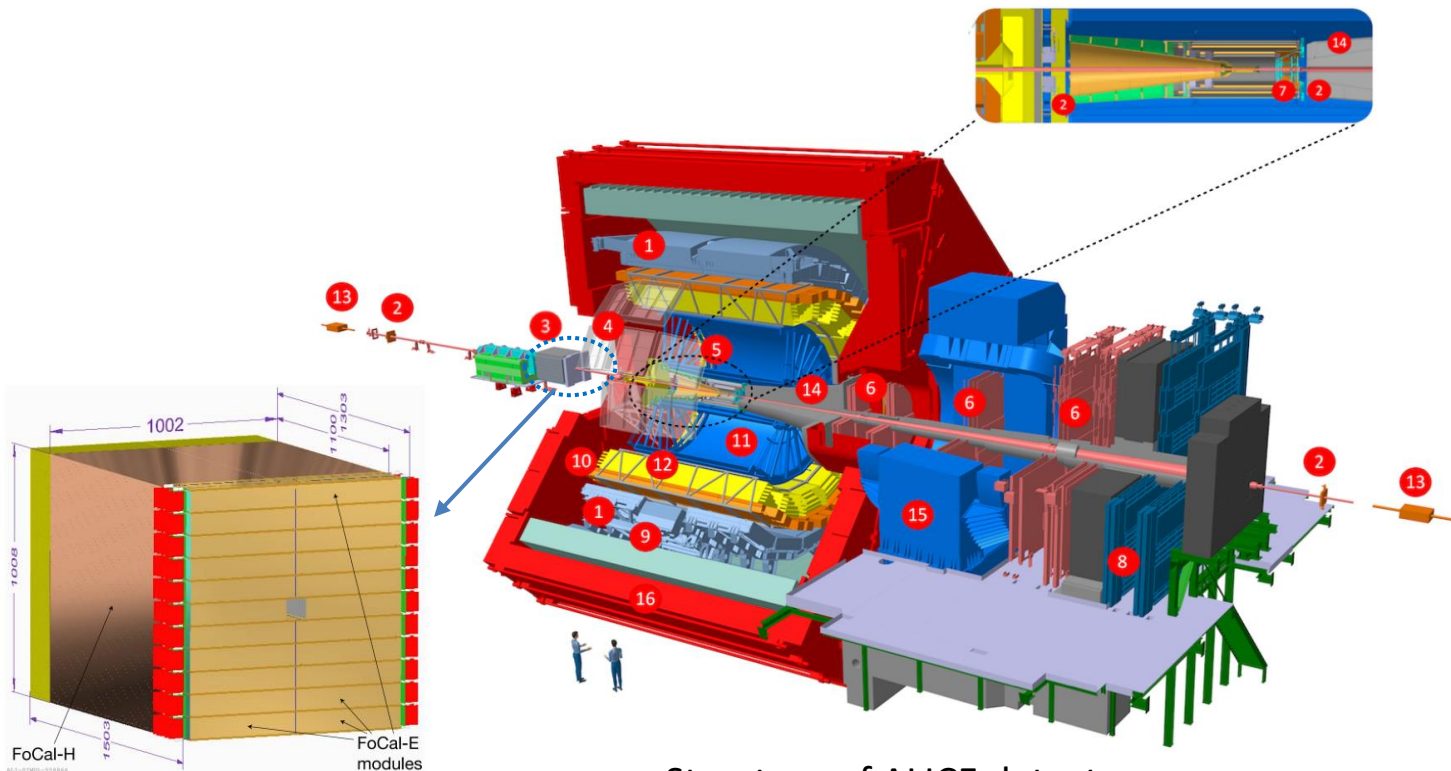


Status on R&D of FoCal Pixel Layers

Jun Liu, Zhongbao Yin, Daming Sun
Central China Normal University

- Introduction to FoCal
- R&D of FoCal Pixel layers
- Summary

Introduction to FoCal

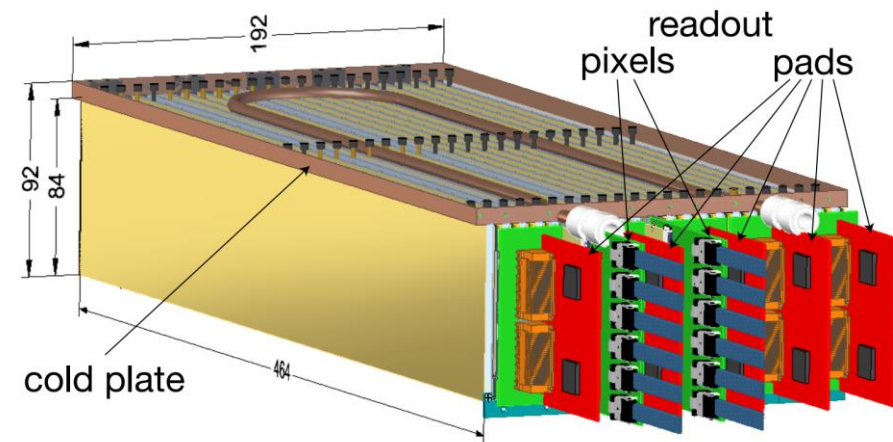
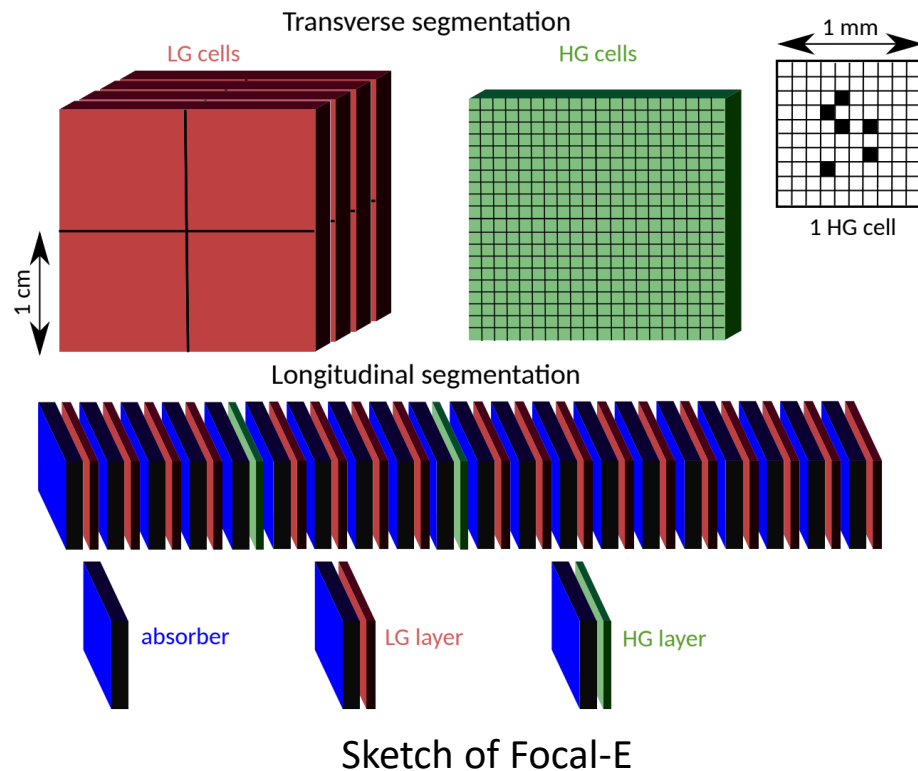


- 1 EMCAL | Electromagnetic Calorimeter
- 2 FIT | Fast Interaction Trigger
- 3 FoCal | Forward Calorimeter (in front of compensator magnet)
- 4 HMPID | High Momentum Particle Identification Detector
- 5 ITS | Inner Tracking System
- 6 MCH | Muon Tracking Chambers
- 7 MFT | Muon Forward Tracker
- 8 MID | Muon Identifier
- 9 PHOS/CPV | Photon Spectrometer
- 10 TOF | Time Of Flight
- 11 TPC | Time Projection Chamber
- 12 TRD | Transition Radiation Detector
- 13 ZDC | Zero Degree Calorimeter
- 14 Absorber
- 15 Dipole Magnet
- 16 L3 Magnet

Structure of ALICE detector

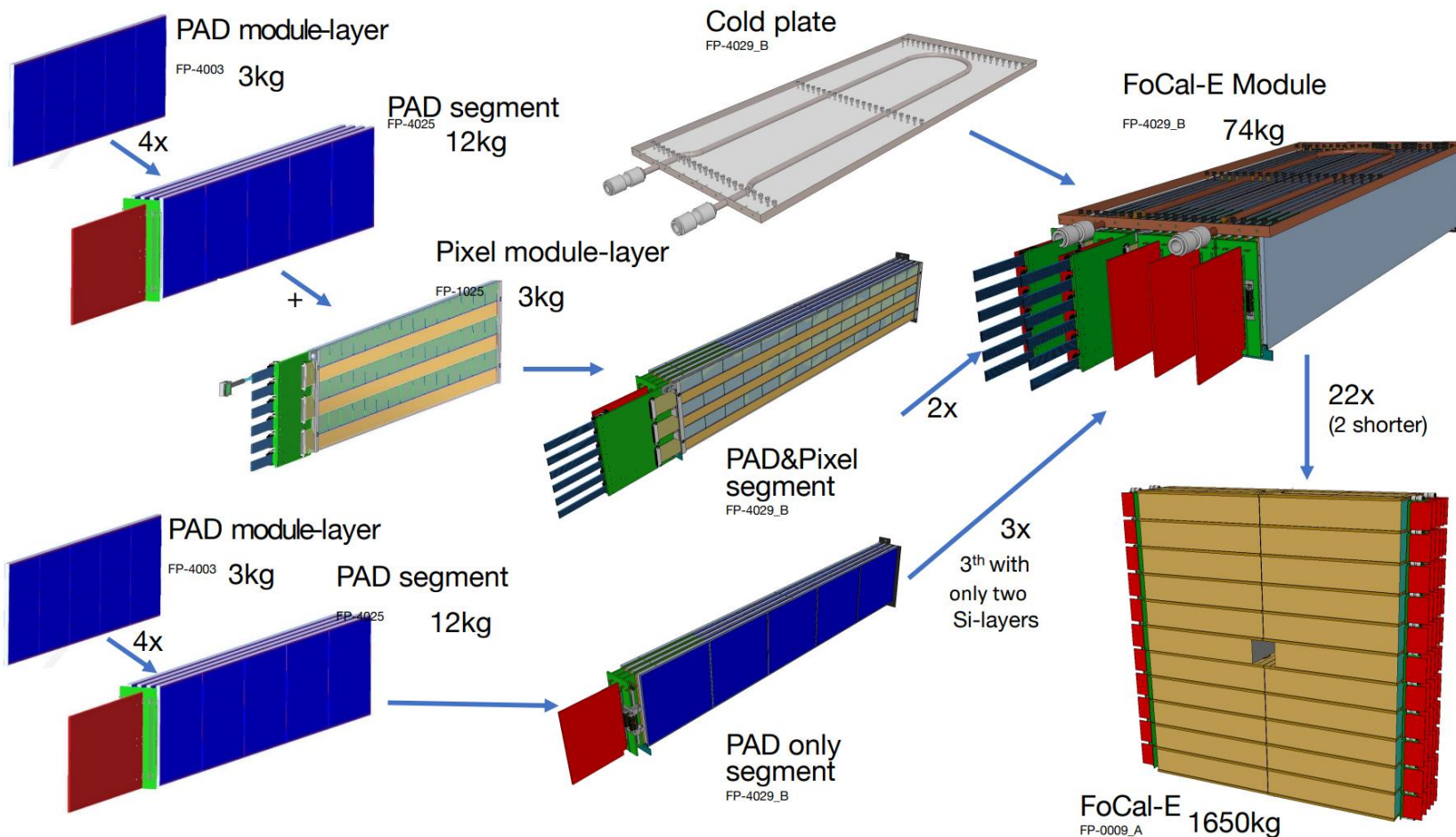
- FoCal is a forward calorimeter as an upgrade to ALICE detector, exploring the small-x parton structure
- FoCal has two components: electromagnetic calorimeter (FoCal-E), hadronic calorimeter (FoCal-H)
- FoCal is located in front of the compensator magnet and outside the magnet doors, opposite the muon arm, about 7 meter to the Interaction Point (IP)
- FoCal installation is foreseen during LS3, to be take data during LHC Run 4 that is currently scheduled during 2030-2033

Sketch of FoCal-E



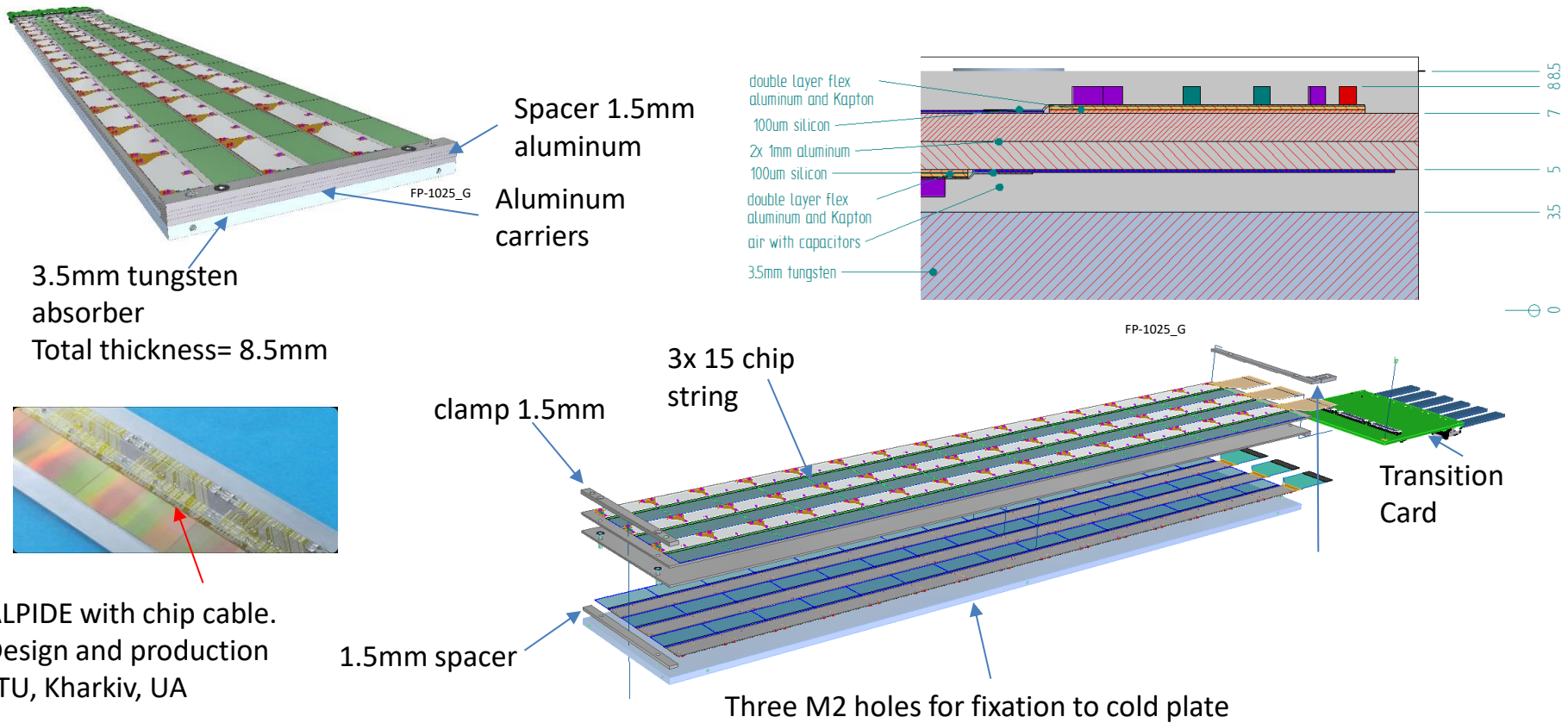
- FoCal-E includes 20 layers of absorber W (each 3.5mm thick) and Si sensors
- FoCal-E has a hybrid design using two different Si readout technologies
 - Si-PAD, low granularity, cell size is 1cm x 1cm, readout by HGCROC chip
 - Si-Pixel, high granularity, pixel size is 30 μ m x 30 μ m, equipped with ALPIDE chip
- Focal-E includes 18 layers of Si-PAD (measure shower energy and shape) and 2 layers of Si-Pixel (decay proton identification)

Assembly steps for Focal-E detector



- Focal-E Module consists of 5 segments and has 20 module-layers in total
- The first 2 segments have 4 Si-PAD module-layers and 1 Si-Pixel module-layer, and the last 3 segments only have Si-PAD module-layers (4+4+2)
- Focal-E has a total of 22 modules, 11 on each side of the beam pipe

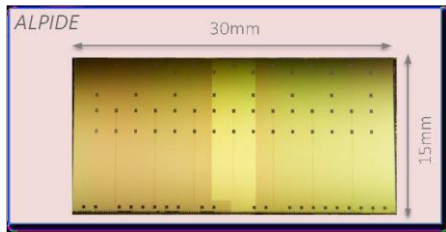
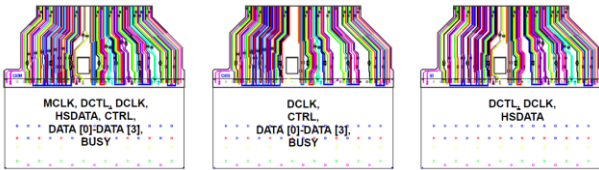
Focal-E pixel layer cross section



- Total thickness: 3.5(absorber)+1.5(spacer)+1(carrier)+1(carrier)+1.5(spacer)=8.5mm
- Pixel layer assembly at CCNU, module assembly at CERN

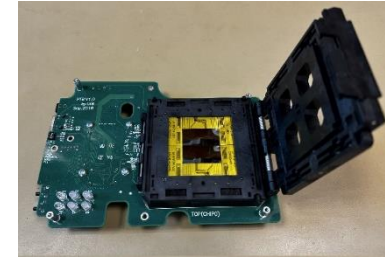
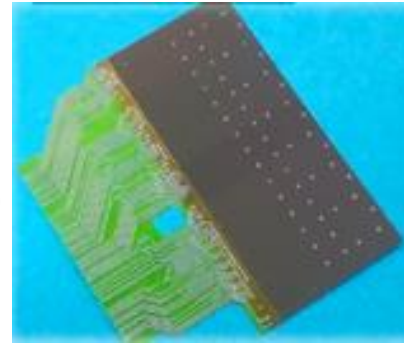
Focal-E Pixel Layer assembly

Chip cable



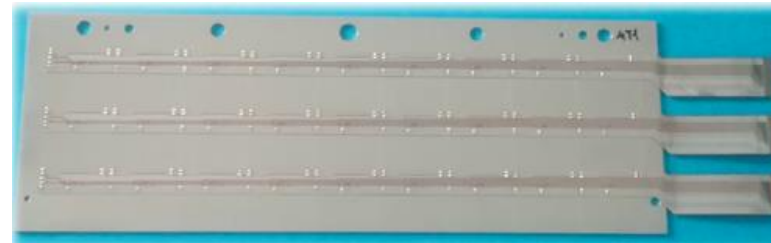
ALPIDE

Single ALPIDE module



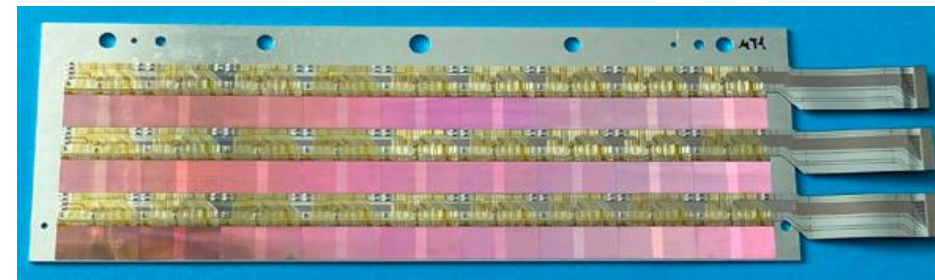
Production test box

SpTAB



Carrier board with flex

SpTAB



Half Layer module

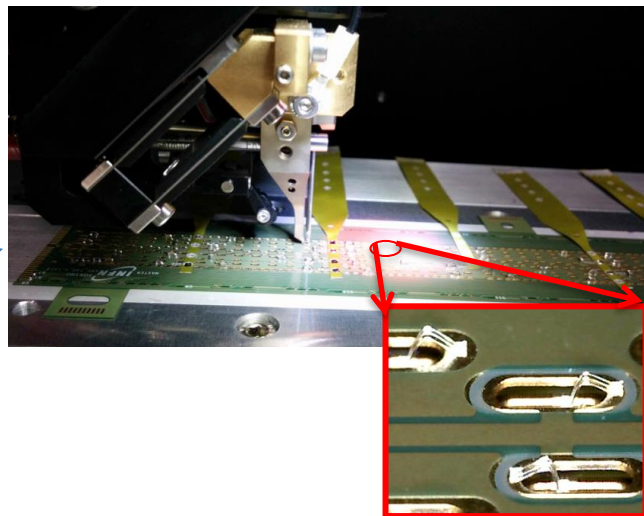
Pixel layer assembly jig

Single ALPIDE Assembly - SpTAB bonding

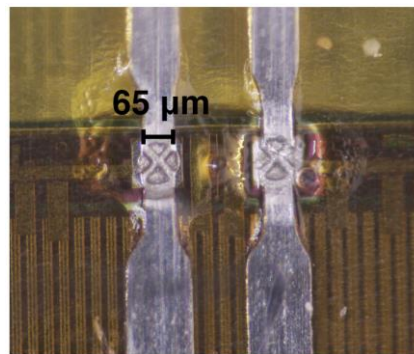


F&K Delvotec G5 64000

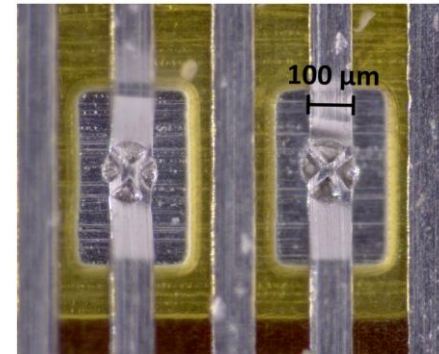
Wire bonding



SpTAB bonding



Chip-to-flex



Flex-to-flex

Single ALPIDE Assembly - SpTAB bonding



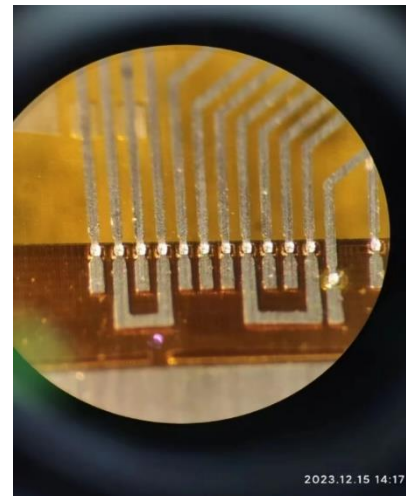
SPT company 7000/7100 tool style

STANDARD DIMENSIONS

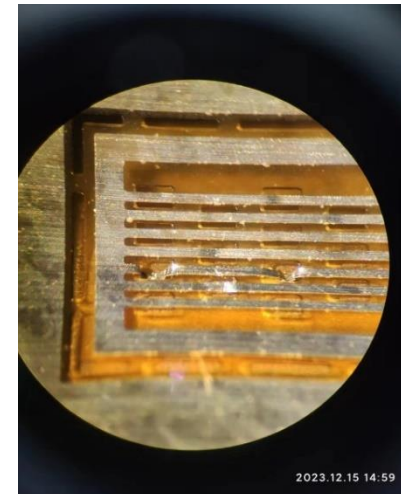
7000, 7045 Tool Style

7100, 7145 Tool Style

W/FL	Foot Width W in / μm $\pm .0002/5$	Foot Length FL in / μm $\pm .0002/5$	T	Tip Diameter T in / μm $\pm .0002/5$
4025	.0040 / 102	.0025 / 64	0030	.0030 / 76
4030	.0040 / 102	.0030 / 76	0035	.0035 / 89
4035	.0040 / 102	.0035 / 89	0040	.0040 / 102
4040	.0040 / 102	.0040 / 102	0045	.0045 / 114
5030	.0050 / 125	.0030 / 76	0050	.0050 / 125
5035	.0050 / 125	.0035 / 89	0055	.0055 / 140
5040	.0050 / 125	.0040 / 102	0060	.0060 / 152
5045	.0050 / 125	.0045 / 114	0070	.0070 / 178
5050	.0050 / 125	.0050 / 125		
5055	.0050 / 125	.0055 / 140		
6045	.0060 / 152	.0045 / 114		
6050	.0060 / 152	.0050 / 125		

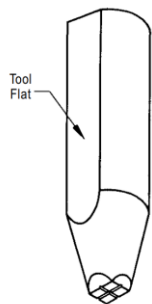


Chipcable-to-chip
(trace width 70um)

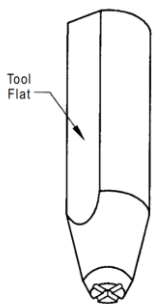


Chipcable-to-flex
(trace width 100um)

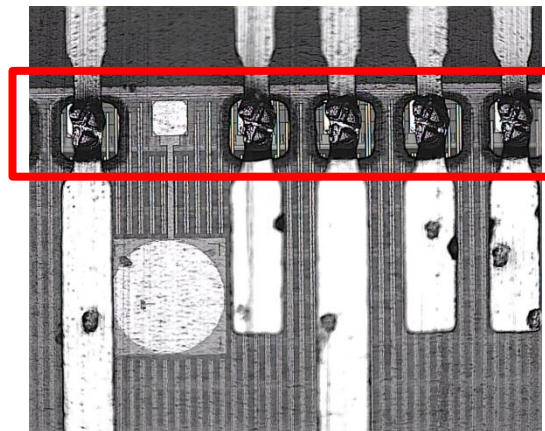
SpTAB bonding with gold plate



7000 STYLE



7100 STYLE

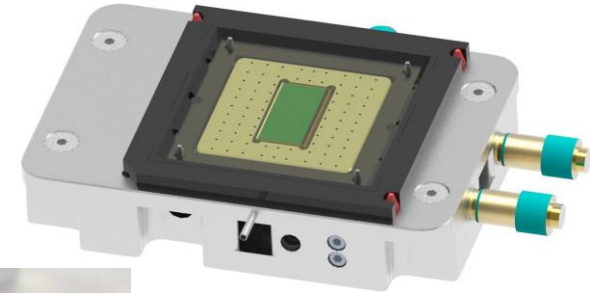


Bonding result in microscope

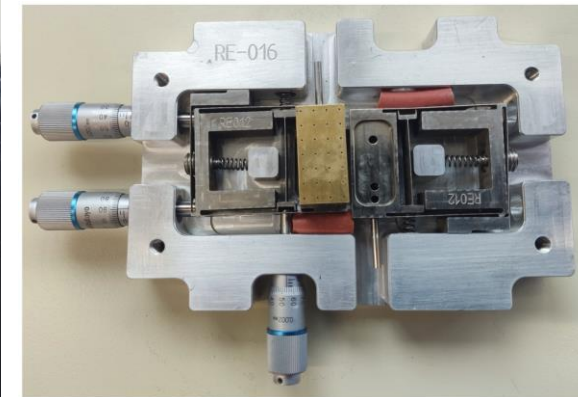


Pull test with DAGE4000

Single ALPIDE Assembly

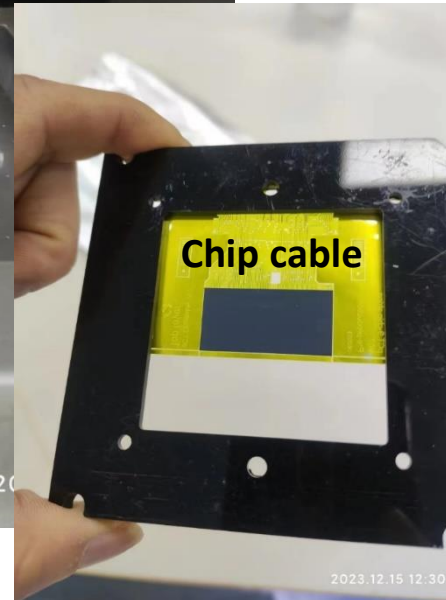


Single ALPIDE Bond Tool



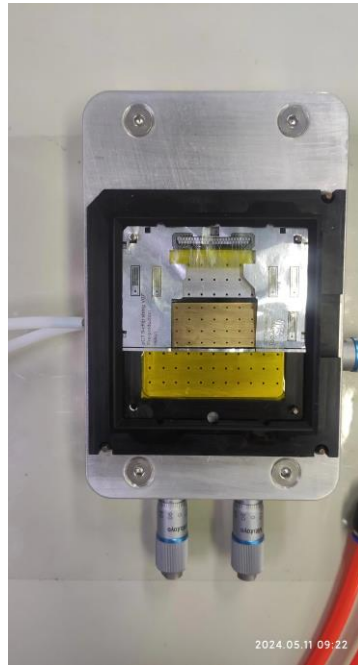
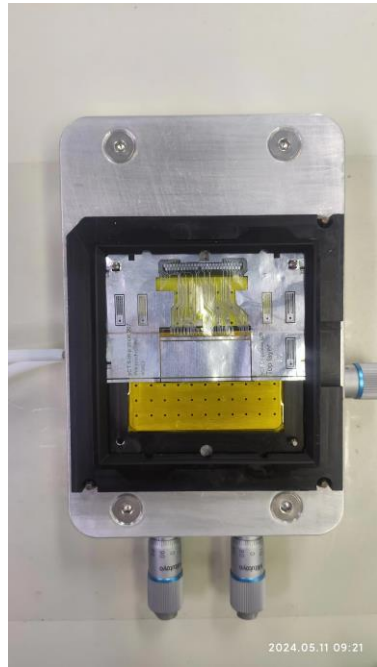
Internal structure of the Tool

To hold the single ALPIDE Bond Tool,
the table of the bonder is lowered by
20 mm



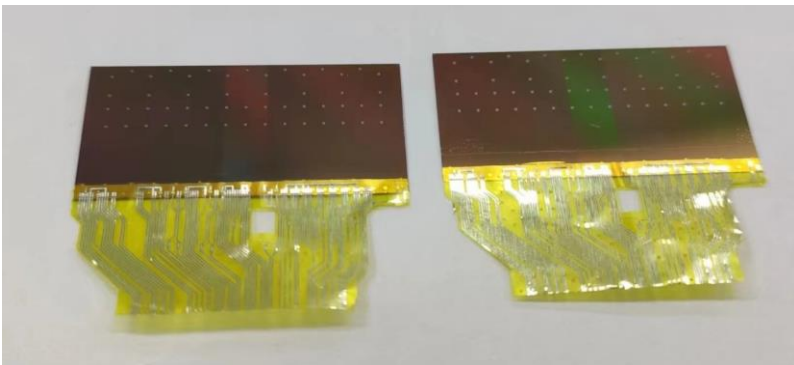
- The Single ALPIDE Bond Tool is fixed on the bonding table and ALPIDE is placed at the center of the Tool by vacuum
- A frame with Chip cable is placed on the Tool through positioning pins to preliminarily align ALPIDE with Chip cable
- Use micro-meter head for high precision alignment of ALPIDE with Chip cable during SpTAB bonding

Single ALPIDE Assembly

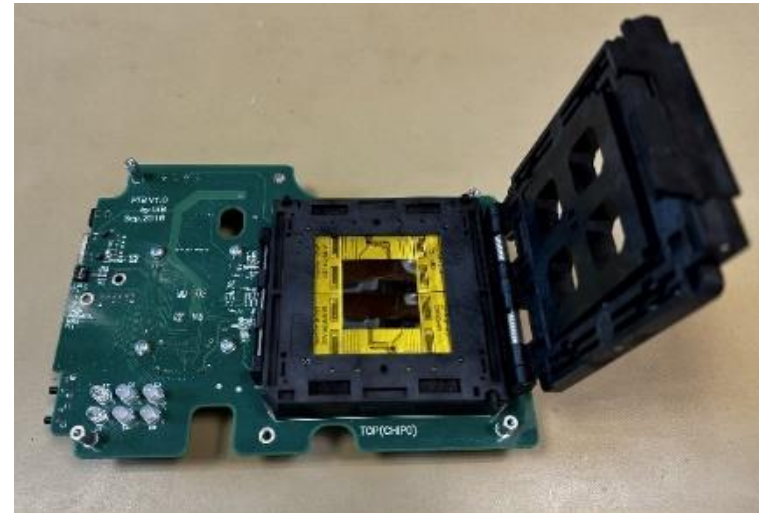


- Cut off the parts after bonding (cutting is carried out along the cutting line by hand at present, and a jig will be used during production)
- A Production Test Box has been developed for functional tests before cutting, only the chip pass the tests can be used in pixel layer production
- China Institute of Atomic Energy participates in the development of firmware

Cut off the part for assembly



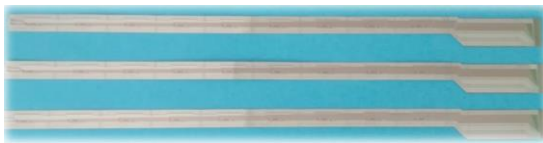
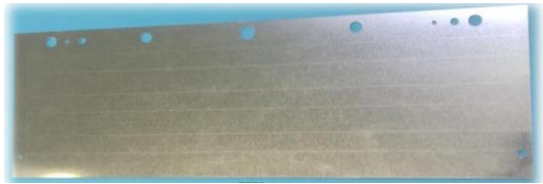
The parts for assembly



Production Test Box

Pixel Layer Assembly

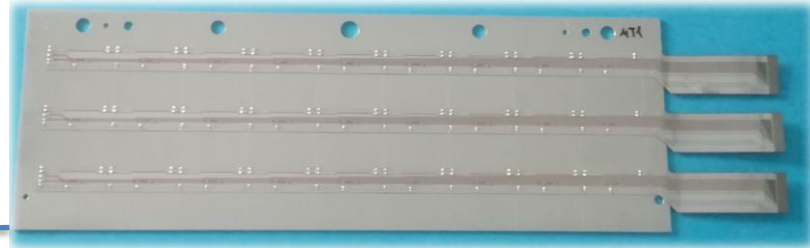
Carrier



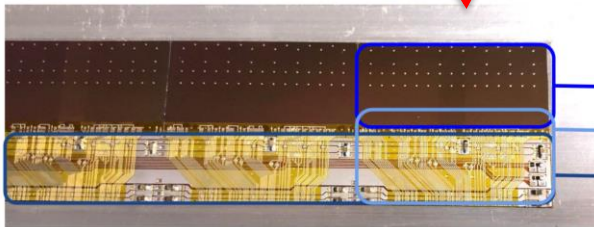
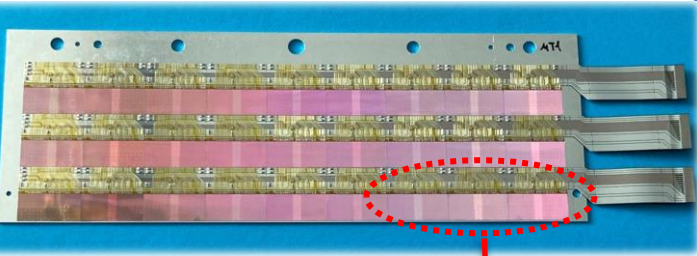
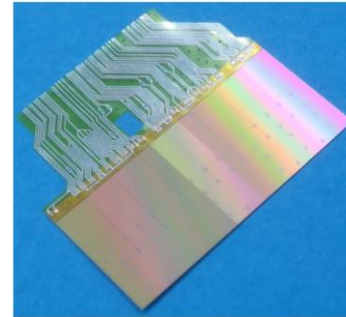
Aligning
Gluing



Carrier with flexes



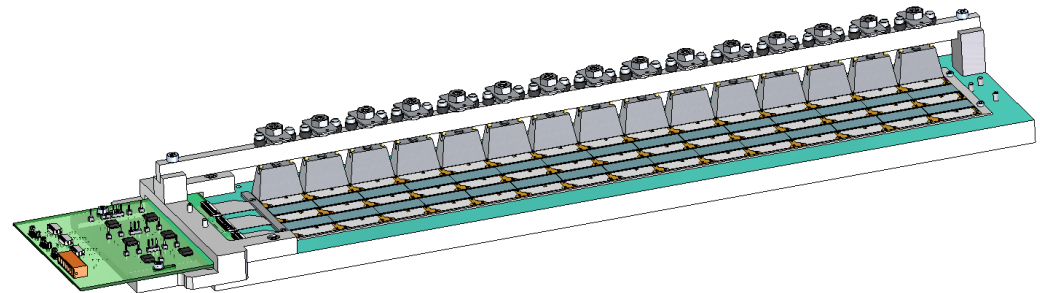
Multilayered flex cable



Sensor

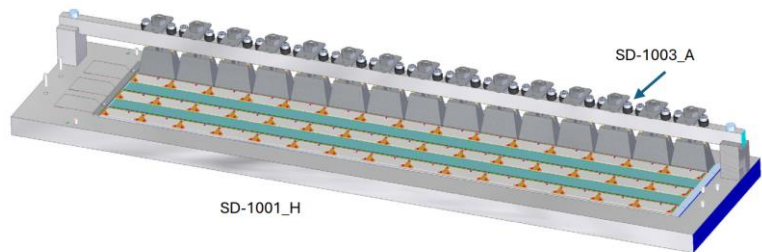
Chip cable

Flex cable



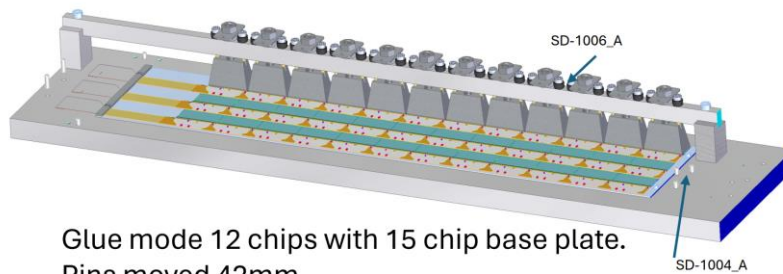
FoCal 15 chip jig

Pixel Layer Assembly

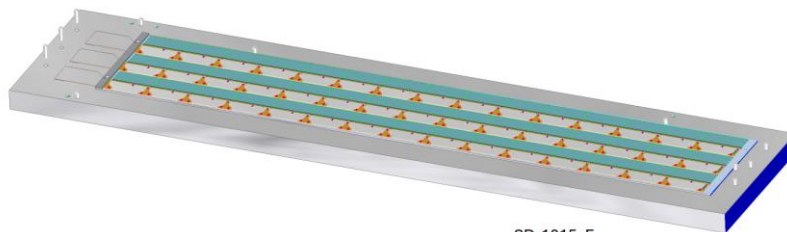


SD-1001_H

Glue mode 15 chips

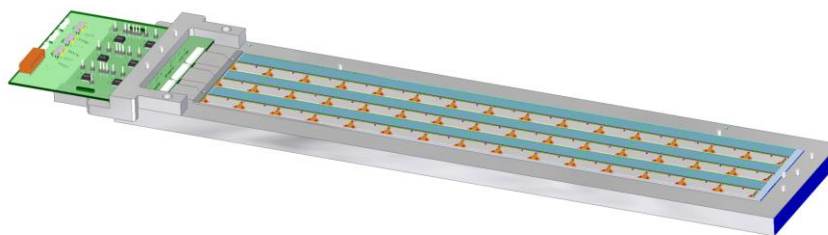


Glue mode 12 chips with 15 chip base plate.
Pins moved 42mm



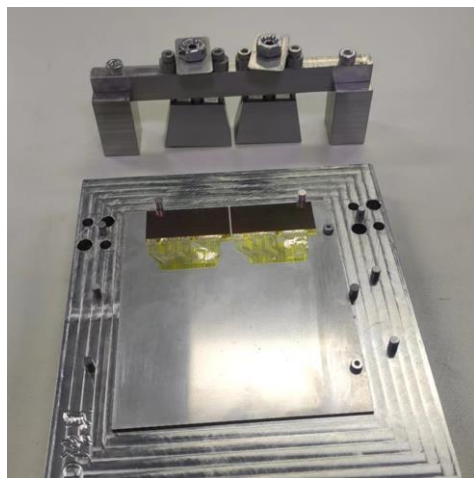
SD-1015_E

Bond mode

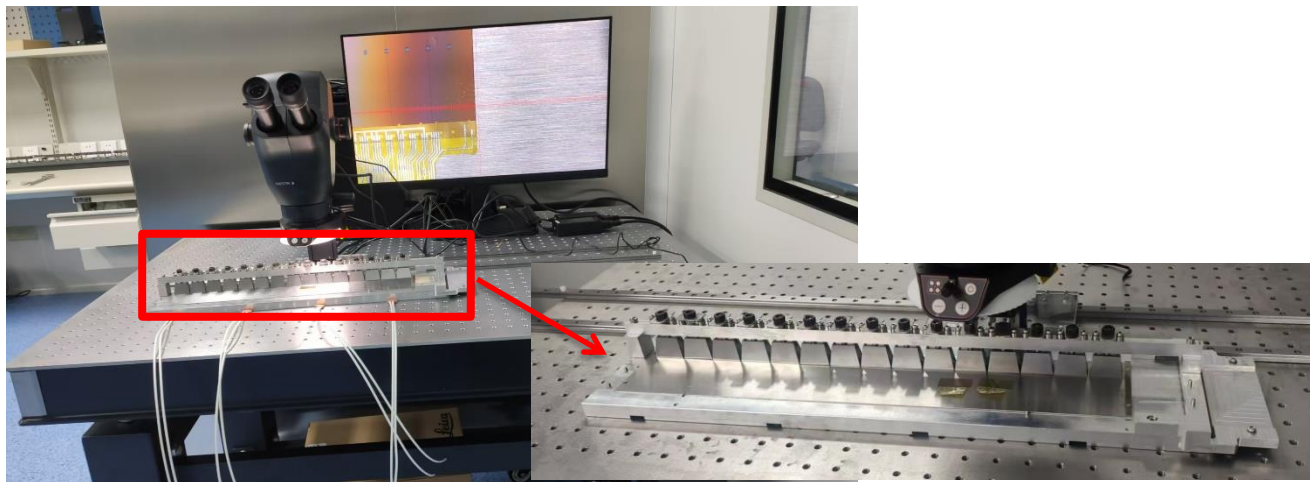


Test mode

SD-1001_H



2 chip jig



15 chip jig

- Replace bonding needle and do the SpTAB bonding test
- Produce Single ALPIDE Bond Tool and finish single chip module assembly
- Produce Multi Chip assembly jig and do some preliminary tests
- Cutting and bending tools are under development
- CCNU lab is ready for pixel layer module assembly



ALICE



Thank You !